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November 19, 1971

RECEIVED
OCT 25 1984
VALLEY REGIONAL OFFICE

Mr. David A. Olson
American Cyanamid Company
Wayne, New Jersey 07470

Dear Mr. Olson:

Re: Piney River, Virginia

Summarized below are the results of our investigation of the Piney River, Virginia, river contamination study. During the period November 7 through November 9, 1971, a field investigation of the plant site was conducted, and discussions were held with the plant manager and engineer, as well as other available personnel. Included below are recommendations for reducing the volume of contaminants that now enter the Piney River from the American Cyanamid Company's plant area.

The State of Virgina has established both chemical and physical limits for the waters in the Piney River. The criteria include a minimum pH level which is set at 6.0. At the present time, contaminated surface water and ground water are entering the river along a broad area at the plant site and alter the pH of the river water as well as adding chemical constituents. For example, samples of the river water upstream of the plant site, during the period of September 15 through November 15, 1971, had a pH range of 6.5 to 7.7. Samples collected downstream at the Rose Mill Bridge between June 18 and November 5, 1971, had a pH range of 2.8 to 4.1. Effluent from the copperas pile from August 23 through October 26, 1971 had a pH range of 1.9 to 3.0.

The plant formerly mined and processed titanium ore, and had been in operation since the mid 1930's but has since ceased all mining and processing operations as of June 1971. Included in the processing was the use of sulphuric acid, which was manufactured at the site. The effluent from the processing was carried to an acid sludge-holding pond approximately 1,000 x 400 feet, which allowed the bulk of the solids to settle out. Figure 1 shows the location of key features at the site. Copperas was used as a floc to settle out the solids, with an estimated 1,000 pounds a day added to the effluent. Periodically, the

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solids were removed and stockpiled elsewhere on the plant property. Two fairly large stockpiles of sludge are shown on Figure 1. It is not known if any other large sludge-storage areas exist.

One of the by-products of the ore processing was ferrous sulfate, commonly called copperas. In addition to being used as a means of settling solids in the acid sludge-holding pond, a large quantity has been stored on the property. A rough survey conducted by Mr. John M. McConaghy, Plant Engineer, in April 1971 indicates the copperas dump contains 4.4 million cubic feet or approximately 200,000 tons of material, covering an area of about 4.5 acres. This area is estimated to be the top, relatively flat portion of the pile and does not include the sloping exposed flanks of the dump.

A monitoring program has been established to check the surface effluent from the copperas pile as well as a sampling profile of the river from a point upstream of the plant site down to the point where the Piney River enters the James River. A chemical analysis of the river water, obviously sampled upstream of the plant site, indicates some important facts. Among these are the low capability of the chemicals in the river water to effectively handle the pH loading. The present process primarily effective in the alteration of the pH of the effluent reaching the river is dilution.

The Piney River has a highly variable flow ranging from about two second-feet to almost 5,000 second-feet. The effluent as surface runoff from the copperas pile has been measured at 4.5 to 45 gpm (gallons per minute) during the period of August 23 through October 26, 1971. In all probability there exists a crude ratio of streamflow to effluent runoff. That is, the higher the streamflow in the river the greater the runoff from the copperas pile.

During the field visit to the site, water samples were collected from the Piney River, some unnamed streams on the property, as well as outfall from buried pipes and the acid sludge-holding pond. Table 1 lists the results of the pH analyses of the samples collected. The sampling points are keyed to the locations shown on Figure 2.

As can be seen, the pH value of the river water changes drastically from a point where it enters the plant property to a point where it leaves the property. In addition, the copperas effluent is not the only contributing factor in the alteration of the pH levels of the river water. For example, the pH of the river entering the plant property is at an acceptable level of 6.7. However, the pH level is unacceptable even before it reaches the vicinity of the copperas pile. This is shown by the sample collected at Station 10, which has a pH of the river water of 5.0, which is below the limit as set by the state.

Several small streams run through the plant property as shown on Figure 2. Sampling

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Stations 11 through 26 were taken from the streams themselves or effluent discharge to the streams. Of the samples collected, only those from Stations 16, 17 and 26 are within acceptable limits of pH.

It is obvious that the basic assumption of controlling the effluent from the copperas pile will not entirely solve the problem. Controlling and neutralizing the laboratory effluent, runoff from the dumped solids from the acid-holding pond, and from the acid pond itself will be necessary.

Several schemes were explored by Geraghty & Miller personnel. They were either discarded because of expense and/or because they would render the pile of copperas unusable for future operations, (We are assuming that the magnetic oxide processing plant will be installed and using the copperas within the near future). However, they are worth mentioning:

1. The injection of gels to completely solidify the copperas pile. Discarded because of expense and the rendering of the copperas into an unusable mass.

2. The use of sulfate and iron reducing bacteria. Discarded because of the problems involved with developing an ideal strain and controlling a proper environment for the bacteria to operate.

3. The physical removal of the copperas pile and carting to an abandoned limestone quarry or other relatively isolated area. Discarded because of the expense in removing the huge volume that exists. In addition, this operation would remove the copperas as a ready source for future operations.

4. Spray the exposed surface with plastic foam and inject gels into the bottom. Discarded because of the uncertainty of obtaining a complete seal on the bottom. In addition, the plastic foam would increase operational costs of future mining.

5. Lowering the temperature of the saturated zone in the pile and/or freezing the entire pile. Discarded because of expense in maintaining the freezing operation. In addition, to be completely effective, the entire pile would have to be saturated and frozen.

In addition to the above, several other plans were considered but are not feasible because of geology, expense and other factors. For example, deep-well disposal by injecting the effluent into the rock was determined not feasible because of the impermeable nature of the rock. Storing of the copperas in the lined acid-holding pond was discarded because of the danger of floods breeching the dike. The simple covering of the pile would not completely stop the effluent from discharging to the river because ground-water in contact with the copperas will eventually reach the river.

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The program we favor at this time consists of several steps applied to the entire plant site. Assuming that laboratory operations are to continue for future operations, the effluent should be collected and treated before the discharge reaches the river. This effluent should not be allowed to flow over the ground but should be carried to the treatment site by direct pipeline. If allowed to flow over the ground, there is always the possibility of the effluent infiltrating into the soil and eventually reaching the river as contaminated ground water.

The buried pipelines, some of them reported to be abandoned, which lead to the river or small streams should be investigated to determine the source of effluent presently flowing from them. If they are abandoned pipelines, then attempts should be made to disconnect and isolate them from possible entrance of liquids. The pipes or the trenches in which they were laid may act as natural conduits, draining the saturated sediments. The trenches which may have been lined with sand for cushioning could have a high permeability with respect to the natural soils surrounding them. The pipes may have corroded enough to collect ground water and allow easy drainage. In any event, the abandoned underground pipelines should be sealed off from all possible sources of contamination, especially in the vicinity of the sulphuric acid plant.

The acid sludge-holding-pond solids should be removed from the present site, and the breeched section of the dam raised to standard wall height. In addition, the solids that have already been removed and dumped on the land surface at several locations on the plant property should be relocated.

The tailings pond south of the quarry may be a suitable location for this material. The pond appears to have been excavated from a predominately clayey matrix that has a very low permeability. If the acid solids are dumped and compacted in a small portion of the pond and then covered with the native clay there would be an excellent likelihood of reducing the effluent load presently reaching the river.

After the solids from the dumps and the acid pond have been removed, an attempt should be made to flush the effluent remaining in the ground. This can be done by spreading a concentrated solution of soda ash or lime over a large area. In areas where the ground water is highly contaminated, shallow injection wells may be necessary.

However, it must be pointed out that the injection of such a solution and the subsequent reaction with the effluent may create a relatively insoluble precipitate which would tend to plug the pore space of the sediments. This will create flow barriers requiring a large number of injection points to cover the area involved.

As an alternative and more practical method of removing the effluent from the sediments, dewatering wells can be installed. This will provide a common collecting point of the fluid, which could be treated on the land surface, thereby eliminating the possibility of plugging the sediments. If possible, any treatment to neutralize the acid should be accomplished so that the end product would be relatively soluable.

Throughout the study, we have assumed that the copperas pile must be kept available for mining in the near future. Some methods previously discussed for controlling the effluent could not be employed because of the effect on the future use of the pile. The method we suggest at this point would be a two-pronged attack to capture and reduce the effluent.

The copperas should be completely covered to eliminate entirely or reduce to insignificant levels the volume of precipitation now entering the pile. In addition, the existing trenches around the pile should be carefully laid out, excavated and lined to divert any surface runoff from reaching the copperas. There is no doubt that the top surface and perhaps the sides of the pile would require some reworking to make a suitable base for a cover.

A suitable cover will significantly reduce the volume of water entering the copperas, but the possibility of ground-water coming in contact with the copperas does exist. Under present conditions, subsurface flow of contaminated water reaching the river could certainly equal or exceed 10 gpm.

To determine the subsurface conditions around the pile we recommend that a series of test wells be installed at selected locations between the river and the pile. Water samples should be collected at various depths as the wells are drilled and analyzed to determine the degree of mineralization occuring at different depths. Based on the results of the chemical analyses and other data, we may be able to determine if preferred paths of travel for the mineralized water exist. Some or all of the test wells could then be used as interceptor wells which would be pumped to keep the effluent from reaching the river. This water could then be treated or, if possible, used for process water and then treated before release to the river.

If the cover is effective, the surface runoff from the pile should be significantly reduced. The volume of ground-water pumped from the interceptor wells may be greater than the present runoff from the pile, however, in all likelihood the degree of concentration of the salts should be less.

Eventually, the discharge from the interceptor wells may be markedly reduced or entirely eliminated by the effective covering of the pile. The reduction of the volume of water that comes in contact with the copperas will be the major controlling factor.

The test well program should be carefully planned so that the most effective locations and materials are used. Figure 3 shows the generalized location of the test wells. The drilling should penetrate the entire thickness of unconsolidated materials, which should be carefully logged. Water samples should be collected throughout the entire saturated

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section for chemical analysis. The actual locations of the wells could be staked for drilling, however adjustment of any particular location will be subject to change based on the data collected on the first boring.

As part of the program to determine the pick-up of contaminants in the river on the plant property, samples of river water should be collected and analyzed for sulfate content. If the river is sampled upstream of the property and at selected points as it crosses the site to a point downstream of the entrance of the copperas effluent, the increase in sulfate content may give an indication of the percentage of contaminants reaching the river as it courses through the property. It is recommended that this sampling program be initiated as soon as possible.

Respectfully submitted,

GERAGHTY & MILLER, INC.

Frank A. DeLuca

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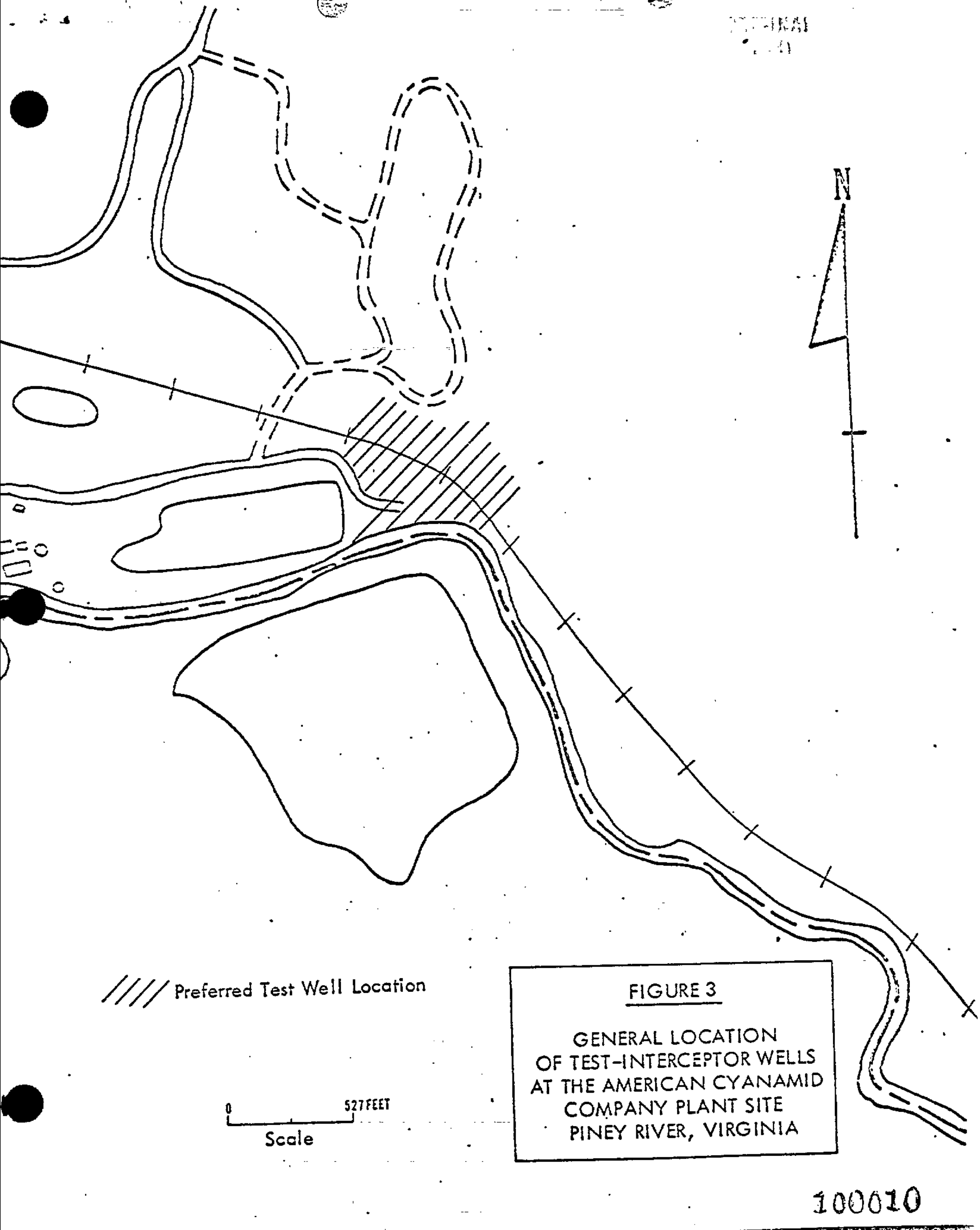

FIGURE 3

GENERAL LOCATION
OF TEST-INTERCEPTOR WELLS
AT THE AMERICAN CYANAMID
COMPANY PLANT SITE
PINEY RIVER, VIRGINIA

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Table 1 - Description of water sampling stations and pH values of samples collected November 10, 1971 at the American Cyanamid Co. plant site, Piney River, Virginia (see Figure 2 for location of sampling stations).

Station No.	Description	pH
1	Piney River at bridge on State Route 151	6.7
2	Piney River at fording point (north side of river)	6.9
2A	Piney River at fording point (south side of river)	6.9
3	Piney River at plant upstream intake point (north side of river)	6.2
3A	Piney River opposite plant upstream intake point (south side of river)	6.7
4	Piney River, 1,500 feet downstream from bridge (north side of river)	6.8
4A	Piney River, 1,500 feet downstream from bridge (south side of river	6.9
5	Discharge from bank and overflow pipe upstream side of footbridge	6.8
5A	Piney River, south side of footbridge	6.9
6	Discharge from abandoned pipe into creek which flows into Piney River	2.7
7	Creek flow upstream from pipe discharge at footbridge	5.9
8	Piney River downstream from sulphuric acid plant (north side)	6.0
8A	Piney River downstream from sulphuric acid plant (south side)	6.0
9	Discharge from breech in acid sludge pond	2.6
10	Piney River upstream from breeched acid sludge holding pond	5.0
11	Unnamed stream south of railroad side tracks in vicinity of copperas pile	3.0
12	do	3.1
13	do	3.1
14	Unnamed stream north side of railroad tracks in vicinity of copperas pile and dump area	2.4
15	do	5.1
16	do	6.0
17	do	6.3
18	Unnamed stream south of railroad side tracks in vicinity of copperas pile	3.1
19	Unnamed stream downstream from solids from acid sludge pond	3.2
20	Unnamed stream north side of acid sludge holding pond	3.0
21	do	2.9
22	Headwaters of stream upstream from sample # 19	3.3
23	Unnamed stream upstream from sample 21 effluent from lab enters this stream	2.0
24	Effluent from lab	2.0
25	Unnamed stream at pipe where effluent from lab crosses	5.8
26	Unnamed stream entering property at bridge	6.4
27	Piney River 800 yards downstream from copperas effluent flow	3.3

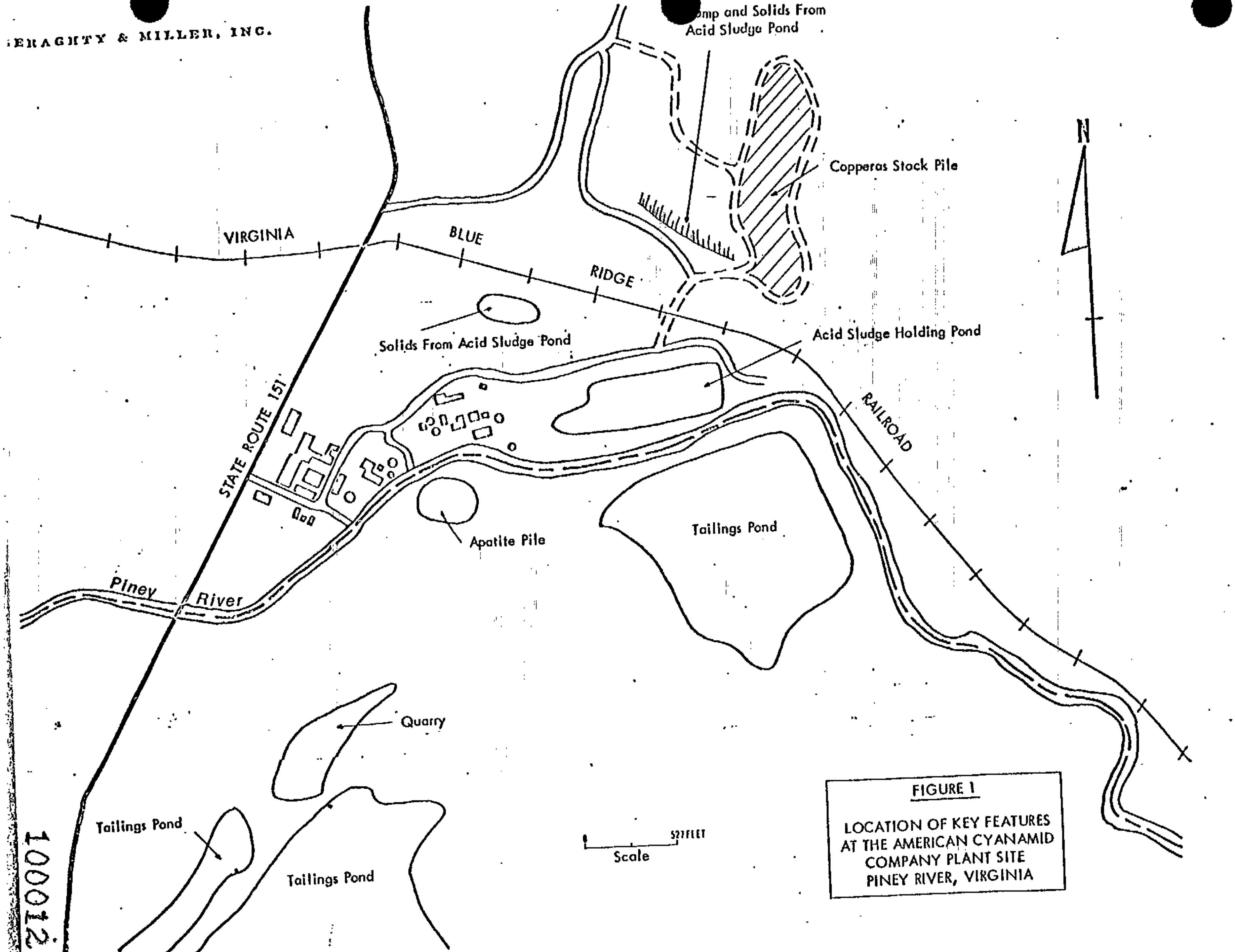

FIGURE 1

LOCATION OF KEY FEATURES AT THE AMERICAN CYANAMID COMPANY PLANT SITE PINEY RIVER, VIRGINIA

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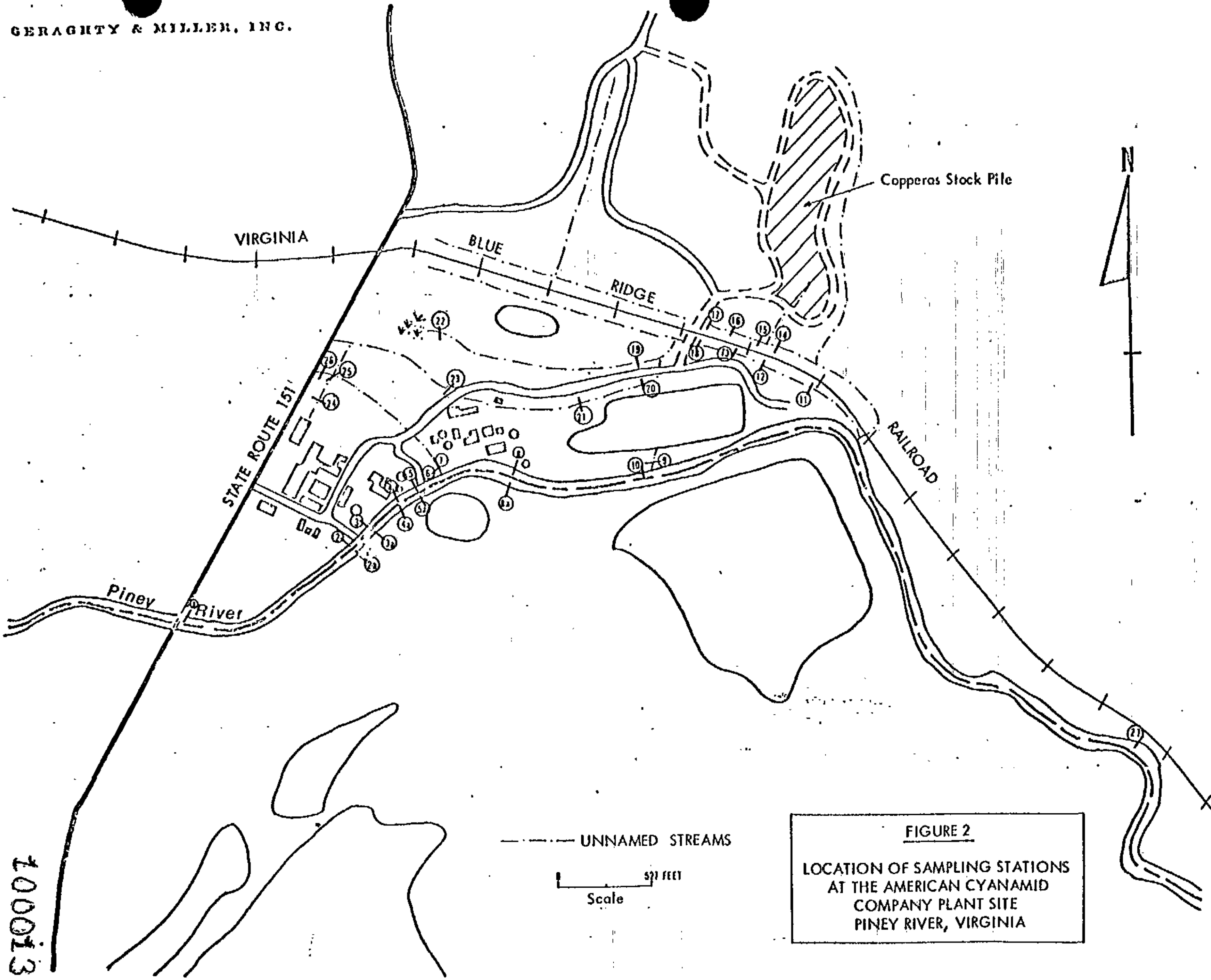

FIGURE 2

LOCATION OF SAMPLING STATIONS AT THE AMERICAN CYANAMID COMPANY PLANT SITE PINEY RIVER, VIRGINIA

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